

Knowledge mapping and other visualization methods perspective usage capabilities for purposeful activities in Latvia

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ABSTRACT

The purpose of this paper is to analyse the status quo and perspectives of using visual knowledge presentation methods, applications and personal devices in Latvia taking into account their widespread experience in western countries and the needs for efficient use of personnel and the communication-oriented knowledge for life management, education, local government management, and business in Latvia. There are considered principles and possibilities of graphical knowledge representation and collaboration techniques and their usability in wide sectors of practical activities. Options of discuss at and compare different options of mental maps applications and examples for the use of certain types of tasks.

Key Words: knowledge maps, systemic thinking, purposeful activities, effective learning, SWOT analysis

1. INTRODUCTION

Knowlegde maps such as mind maps and concept maps in western countries over the last decade has shown increasing prevalence of a wide range of household and business sectors. As their founders may be considered British psychologist Tony Buzan, who has already developed this theory since 1980 (Buzan, 1980); Novak, J., & Cañas A. (2008). These theory define mind maps and concept maps as the quite a simple instruments for problem solving support that is based on graphical representation of concepts and their binding links as spidergram or diagram to be used for training, planning, decision-making and operational cooperation of partners in solving different tasks. Most of these tasks can be solved in a piece of paper, but much more effective they can be carried out using personal devices. Although mind maps usage is also possible without a PC apps but the prevalence of these options greatly expands. For example some application areas are shown in the figure 1 taken from Frey, C. (2010).

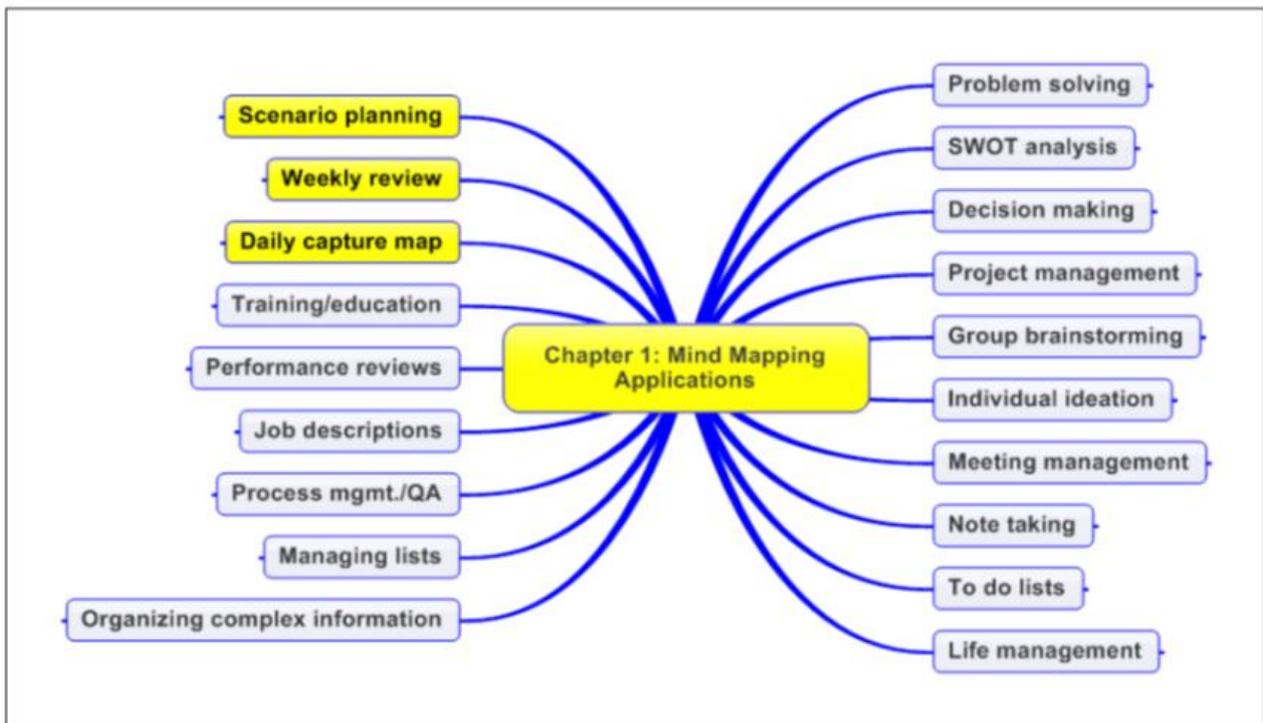


Figure 1. *Some areas of mind mapping applications. Frey, C. (2010)*

Over the past ten years there have been soared personal devices (smartphones, tablets, personal computers) use among the general population in Latvia, as well as in other countries with increased visual information display options. It is therefore becoming increasingly topical question of efficient their usage of not only for entertainment purposes, but also a wide range practical tasks solving for example as effective learning or targeted planning both in personal and business environment. As advantages of visual and graphical information presentation methods using could be mentioned their agility that the person can it easier understand and faster to use for decision taking. Therefore they are widely used in a wide range of sectors, for example such as traffic signs, which are necessary for quick decision-making, is used directly in this way.

The current personal and mobile devices use the stage of the actuality has become a problem, the way in which they can enhance the capacity of the human mind. To this end, more and more are used in methods and technologies based on the use of mind maps theory. Currently, studies and tools developed by the introduction of these applications are booming and in their development and analysis are involved many scientists and engineers, but this product penetration rates in Latvian is still insufficient and the current issues are undervalued (Ermuiza, Kalnina and Kazaine (2014)). Nevertheless taking into account the need to improve the education, business, and communities to improve opportunities for cooperation, the introduction of these methods is very urgent need in Latvia.

It can be considered that the use of these methods and tools is very useful to any person including students, businessmen, local and parliamentary staff. These technologies works well for any person of competence for growth and efficient acquisition of teaching material and project planning and long-term development strategies and management.

The aim of this article is to analyze existing methods and tools available options in western countries and make recommendations to encourage the rapid implementation of these methods and tools in wide areas of activities in Latvia.

2. METHODOLOGY

During the development of theory of mind maps and their applications in western countries they are widely expanded and there are detached such branches as the concept maps and argument maps (Davies, M. 2010) whose applications as a part of knowledge-mapping software are particularly important in the education sector. Lately, they are particularly used in learning subjects in distance education, where the communication options of teachers and students usually are limited. It should be emphasized that the applications of these tools are always such that an individual must be actively and purposefully involved in planning, decision-making and using of the corresponding information processes. Next to those of knowledge processing methods for specific purposes are also used in many other methods and tools, which are often combined offering certain business applications

The comparative analysis of above mentioned means quite comprehensively is carried out in the studies conducted by Davies, M. (2010). He shows basic characteristic features of mind maps, concept maps and argument maps and their advantages and disadvantages in the branches of specific disciplines.

Table 1. Summary of the differences between knowledge-mapping software (Davies, M. (2010))

	Purpose	Structure	Level of abstraction	Nodes	Linking devices	Linking words
Mind maps	Associations between ideas, topics or things	Non-linear, organic, radial	High generality	Pictures, words, diagrams	Lines, line thicknesses, colours, shading	Associative words ("Use" and "colours" and "links")
Concept maps	Relations between concepts	Hierarchical, tree-like	Medium generality	Boxes	Arrows	Relational phrases ("in relation to", "is composed of", etc.)
Argument maps	Inferences between claims (conclusions) and support (premises)	Hierarchical, tree-like	Low generality	Boxes and lines	Lines, colours, shading	Inferential linking words ("because", "not", "however")

2.1. Mind mapping

The important role in the usage of **the mind maps** played the researches of the English psychologist T. Buzan (1980), who supported the use of its utility. The mind map is a diagram used to present words, ideas, tasks or other items connected to the central key word. In English it is sometimes called a „spidergram”. These maps are used to generate, to visualize, to structure or classify the ideas, tasks or sub-tasks, to organize the information, to make decisions and, for ex., to make the publications. They also can be used during the so called „brain storming” sessions to organize and structure the ideas. It is important to underline that in contrast to the traditional studying programs the graphical depiction of the relationship between learning themes gives a better opportunity to understand the subject’s structure that is especially important if using modern technologies in the learning process. Then it can be stored as a part of someone’s personal

knowledge in the flash or in the „cloud” and used while being contacted with a teacher or while being tested.

The components of mind maps can be supplemented by the Internet addresses where the additional information is given. At first, during this studying process that can be called very elastic the basic subjects’ concepts, the structure of the system and the further learning methods are acquired. Literary it can be compared with the tree trunk. Later the student’s research work or the results of the project work can be compared with the tree branches and leaves. The advantages of mind mapping include its “free-form” and unconstrained structure. In accordance with Davies, M. (2010) there is no limits on the ideas and links that can be made, and there is no necessity to retain an ideal structure or format. Mind mapping thus promotes creative thinking, and encourages “brainstorming”. A disadvantage of mind mapping is that the types of links being made are limited to simple associations. Absence of clear links between ideas is a constraint. Mind maps have been said to be idiosyncratic in terms of their design, often hard for others to read; representing only hierarchical relationships (in radial form); inconsistent in terms of level of detail; and often too complex and missing the “big picture” (Eppler 2006; Zeilik, 1997). Mind mapping is also limited in dealing with more complex relationships. For example, mind mapping might be useful to brainstorm the things that are critical for students to recall in an exam (or a presentation, as in the example provided). However, it is hard to see it being useful for a purpose that requires an understanding of how one concept is essential to understanding another. More complex topics require more than an associational tool, they require relational analysis. The tool of concept mapping has been developed to address these limitations of mind mapping.

Table 2. Advantages and disadvantages of hand-drawn and mapping software usage

	Advantages	Disadvantages
Hand- drawn Mind Maps	<ul style="list-style-type: none"> A. No Cost B. No restrictions on map design and layout C. May create map anytime with pencil and paper D. Each map is a unique creation of the user E. E. Collaboration possible if colleagues are together in same place 	<ul style="list-style-type: none"> A. Cannot be digitally stored other than as a scanned document B. Map size is limited C. Preference of user for mind mapping software advantages
Mind Mapping Software	<ul style="list-style-type: none"> A. Ability to link to other information such as hyperlinks and notes B. Ability to modify and filter map easily C. Ability to integrate into other Software D. Ability to create templates easily E. Ability to allow real-time collaboration F. No size limits 	<ul style="list-style-type: none"> A. High cost of none free- source software B. Requires computer access C. Learning curve of using software D. Map design flexibility restricted by software options E. Preference of user to hand-draw map F. Map sharing restricted by format incompatibility

2.2. Concept mapping

The mind maps are often compared with the concept maps. The difference is that the first one has a tree structure, but the second has relations between the concepts though both are used as the parts of the personal databases.

The concept map according definition Novak, J., & Cañas A. (2008) is a diagram showing the relationships between the concepts. Mostly they are used in connection with graphical tools to create them, to organize and depict the knowledge. They consist of the concepts showed in the shape of the circles or rectangles. In the link diagrams they are interconnected with links representing relations between the concepts. According to the definitions the concept is the generalization created in the man's consciousness or the abstraction reflecting the subject's or the phenomenon's essential features. The words or the phrases in the diagrams represent the meanings of the concepts or the relations between them. The example of the concept maps showing the usage features is shown in the Figure 2.

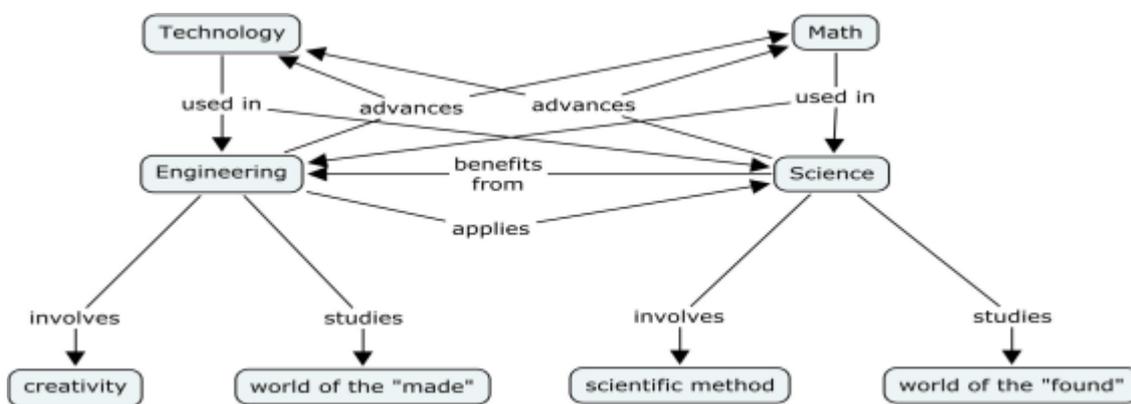


Figure 2. *The example that shows characteristic features of the concept map.*

2.3. Argument mapping

In accordance with Davies (2010) argument mapping has a different purpose entirely from mind maps and concept maps. Argument mapping is concerned with explicating the inferential structure of arguments. Where images and topics are the main feature of associative connections in mind maps, and concepts are the main relationships in concept maps, inferences between whole propositions are the key feature of argument maps. “Arguments” are understood in the philosopher’s sense of statements (“premises”) joined together to result in claims (“conclusions”). Unlike mind mapping and concept mapping, argument mapping is interested in the inferential basis for a claim being defended and not the causal or other associative relationships between the main claim and other claims. The software also allows for an automatically-generated description of the argument in text-form. In some template argument formats - provided with the software - the mapping program also constructs a prose version of the argument complete with a limited display of linking words. Creating argument maps requires resources and technology of some kind. The most obvious and accessible technologies are pen and paper or whiteboards, but these quickly reveal their limitations: poor support for complex diagrams and modification of diagrams, and failure to constrain, scaffold or guide the user in any way. An important recent development is the growing array of collaborative online argumentation tools such as Debategraph, though good user

interfaces for online argument mapping remain an important challenge (Van Gelder, T. 2010). Argument maps support Critical Thinking by providing a convenient and highly effective way to analyze the exact structure of an argument, showing just those elements that are relevant to making your judgments. While the mapping process itself encourages clearer thinking, a good argument map articulates the reasoning clearly, making it easier to consider the case systematically Twardy, C. R. (2013).

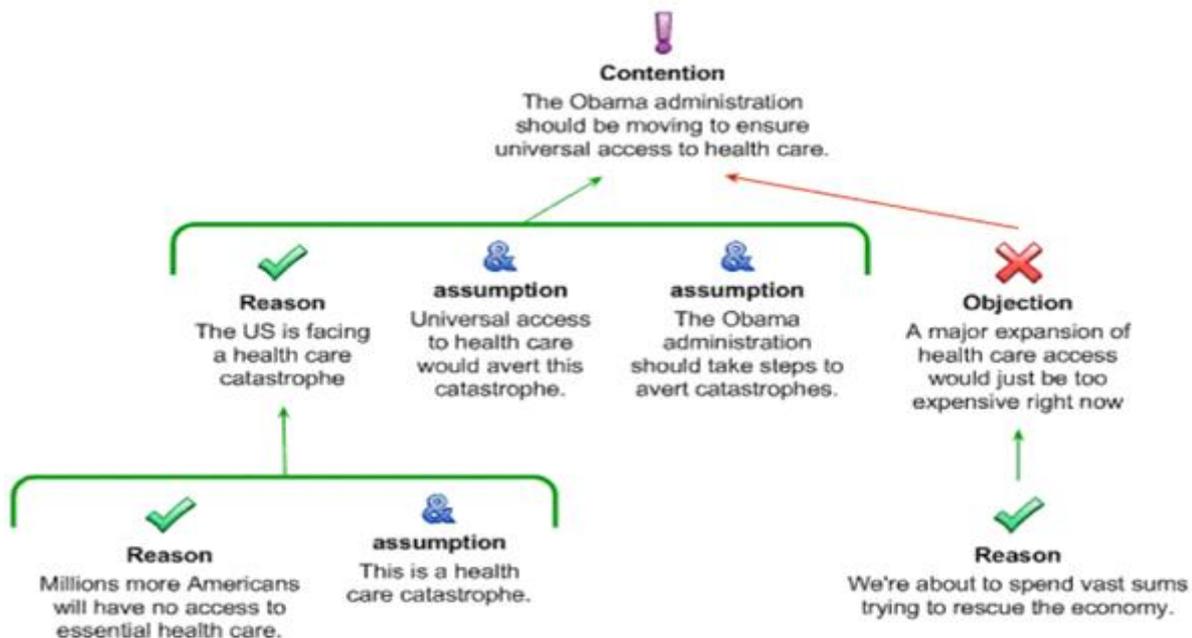


Figure 3. Example of argument map. From Van Gelder, T. (2010).

2.4. Comparison and analysis mapping techniques

In this way Davies (2010) suggested that for education purposes the various mapping tools have complementary functions. Mind mapping is an associational mapping tool; concept mapping provides a way of mapping relationships; argument mapping focuses on maps of inferential structures and logical connections. However, existing technologies already available, to enable a convergence of these mapping tools. All mapping tools function to improve student learning in the ways just mentioned. All of them require the pedagogical advantages of map-making to supplement and drive student learning. What is needed is a way of combining these advantages in an educational tool that provides more flexibility and power than the separate tools that exist at present. A schematic plan of how the comparative functions of each of the tools might be integrated is presented in Figure 4.

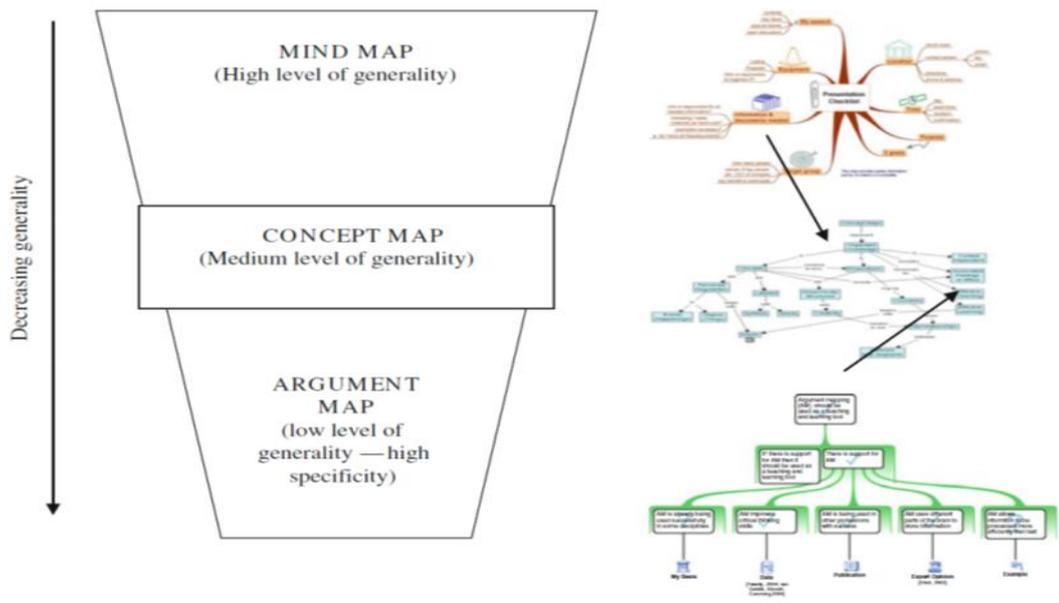


Figure 4. *Proposed convergence of knowledge mapping technologies into a single integrated platform. From Davies (2010)*

2.4. SWOT and PEST analysis

As given in explanation Riccentre (2010) the SWOT (Strengths Weaknesses Opportunities Threats) analysis technique is an extremely useful tool for understanding and reviewing the company's or person's position prior to making decisions about self-state assessment in the environment or future company direction or the implementation of a new business idea. A SWOT analysis can be completed by an individual or within the organization. As shown in Figure 5 from Wenzhong, Z. (2009) the top row of table is internal and the bottom row is external. As the left column is helpful and the right column is harmful then the purpose of personal activities must be to maximize the issues of strengths and opportunities of left column and minimize the weaknesses and threats of right column the table. See also SWOT blog (2012).

The PEST analysis is a tool to evaluate external factors and more oriented to strategic planning. It is often helpful to complete a PEST analysis prior to a SWOT analysis, although it may be more useful to complete a PEST analysis as part of, or after, a SWOT analysis. A SWOT analysis measures a business unit; a PEST analysis measures trends and changes in the market. A SWOT analysis is a subjective assessment of information about the business that is organized using the SWOT format into a logical order that helps understanding, presentation, discussion and decision-making.

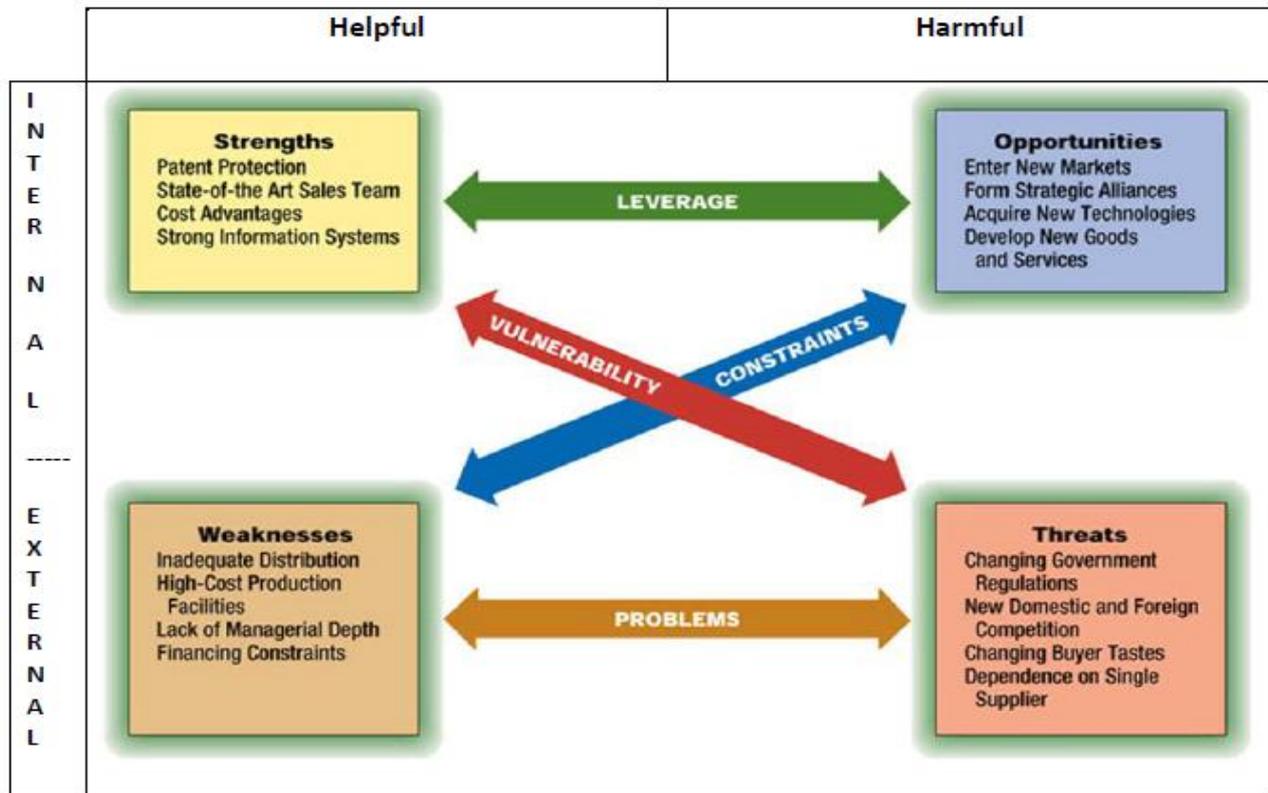


Figure 5. Components of SWOT, from Wenzhong, Z. (2009)

2.5. System thinking approach

Systems thinking provides the ability to observe the deep structure of systems, transcend the simplistic linear cause/effect relationships and apply the language of archetypes across different disciplines Santiago (2011). As recommended ISE Systems (2006) systems thinking usually adds value when situations are:

- Problematic
- Long-standing
- Resistant to change interventions

Systems thinking is often helpful as a planning resource particular in strategic sector. A systems view can help you plan for growth, anticipate limits to growth, predict and avoid actions that can undermine partnerships, and avoid shooting yourself in the foot (by producing a worse situation than you already have). In general, Systems Thinking rarely helps us find the single right answer; other problem-solving tools are more efficient in cases where there truly is an answer. Systems Thinking provides the most value when it illuminates the possible choices embedded in complex, divergent problems, and their likely consequences. Do use Systems Thinking to:

- Identify or clarify a problem.
- Increase creative discussion.
- Promote inquiry and challenge pre-conceived ideas.
- Bring out the validity of multiple perspectives.
- Make assumptions explicit.
- Sift out major issues and factors.
- Find the systemic causes of stubborn problems.
- Test the viability of previously proposed solutions.
- Explore short and long term impacts of alternative or newly proposed solutions or actions.

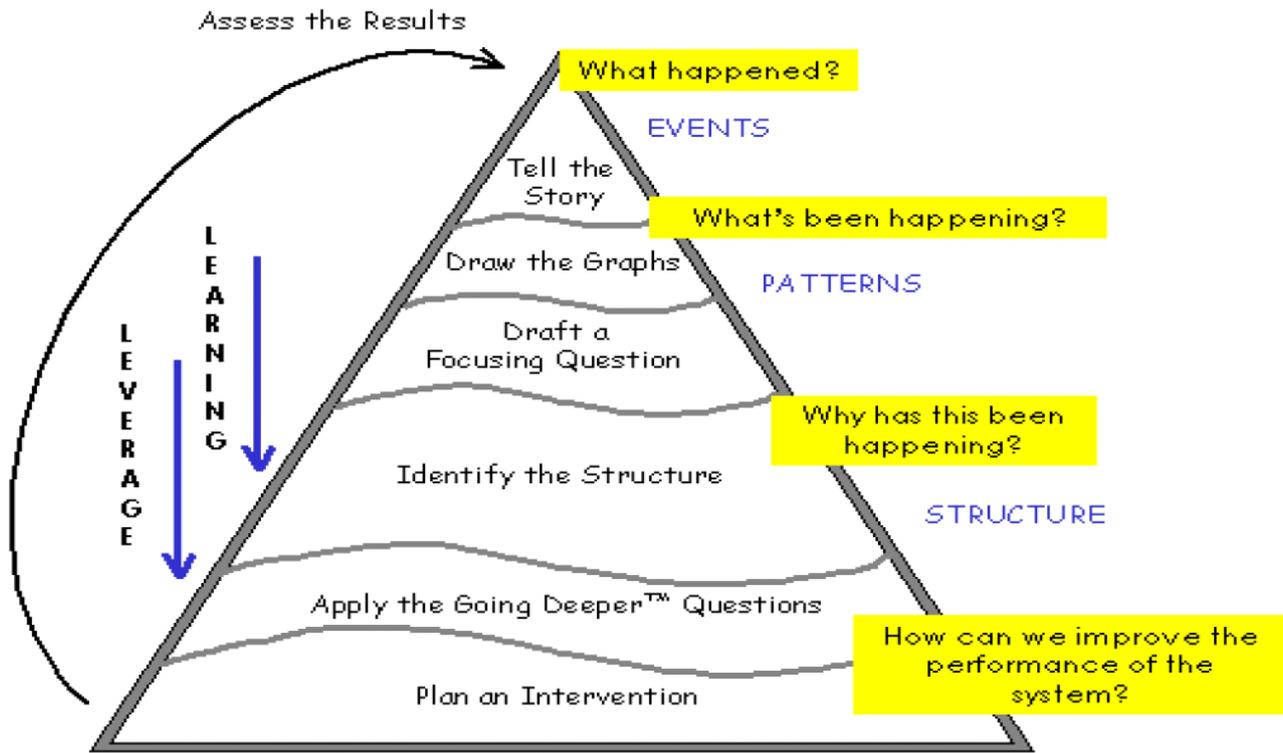


Figure 6. Schema of system thinking approach activities from isee systems (2006)

It should be mentioned that this approach necessary for strategic planning Goals C, 2003.

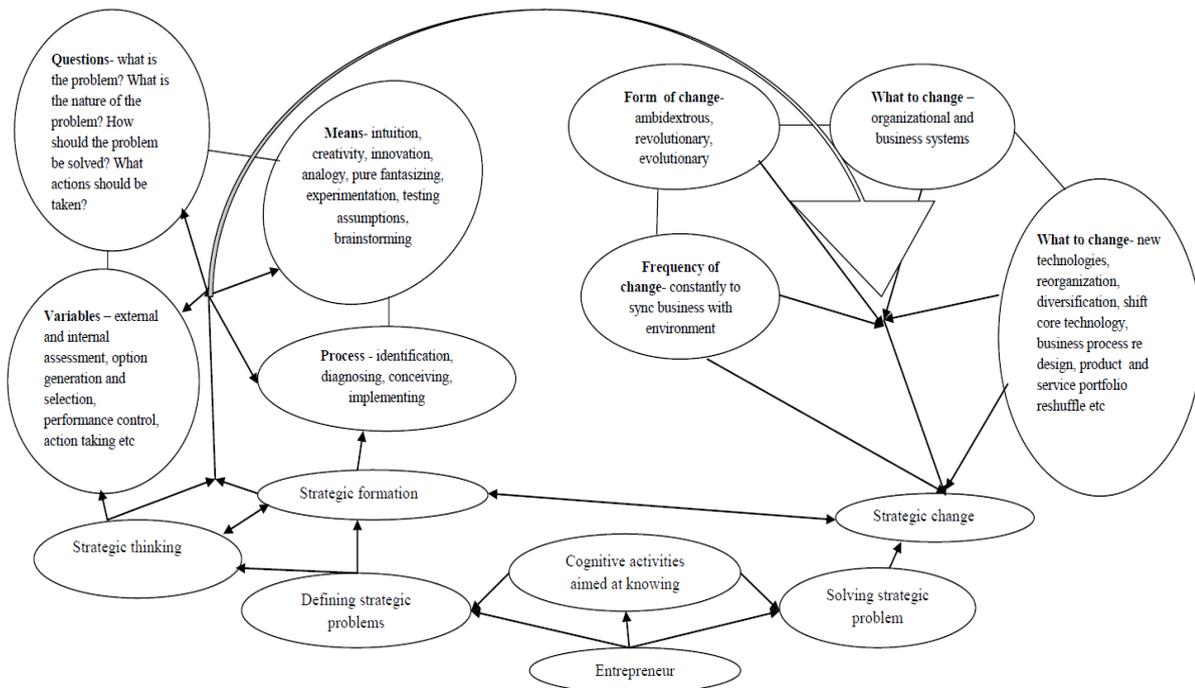


Figure 7. The Cognition Processes of the Entrepreneur when dealing with a Strategic Problem Aberbrese, (2013)

2.6. Top knowledge mapping tools

Over the last years it has developed a wide range of knowledge mapping tools, based on the methods detailed considered above and may be applied for practical challenges in the sectors below mentioned. It should be noted that many of the tools intended only for certain device platforms, which can cause incompatibility problems. Therefore it is appropriate to take into account the cross compatibility in order to avoid possible incompatibility problems if different devices has been used. The use of the tools listed in the table 2 are not among the platform limitation.

Table 2. Cross Platform Tools from The Ultimate Guide to Mind Mapping Software (2015)

Mindjet	Windows, Apple, iPad, iPhone, Android, online
iMindmap	Windows, Apple, iPad, iPhone, Android, online
MindMapper	Windows, iPad, iPhone, Android
XMind	Windows, Apple
MindGenius	Windows, iPad
Mindomo	Windows, Apple, iPad, iPhone, Android, online
TheBrain	Windows, Apple, iPad, iPhone, Android, online
Inspiration	Windows, Apple, iPad
Freeplane	Windows, Apple, iPad, iPhone, Android, online

2.6. Usability of visual thinking methods and tools in western countries

The usage of knowledge maps and other graphical techniques is now prevalent in all sectors of human activity and are widely advertised by marketing companies. For example there is created the portal biggerplate (2016) that yearly collects information about users of these tools in different countries.

There are many human activities sectors of knowledge maps and other graphical techniques usage such as:

- life management, (Life management (2010)).
- personal organizers,
- brainstorming,
- strategic planning,
- education, in particular distance learning and learning results assessment,
- adult and self-directed learning,
- local government management,
- business projects planning and management
- entrepreneurship management (Aberbrese (2013))
- planning and management of the interethnic dialogue,
- human security activities planning and management,
- purposeful web browsing
- software specification development

Life management – is a complex dynamic system, consisting of a several interconnected parts. First of all, you should find out your main life values, the main goal of your life and the strategy that will

help you to attain this goal. That is strategic planning. Of course, your main goal will be complex and compound. For example, if your main goal is happiness, you should find out – what do you need to be happy. The next stage is operating planning: brief review of your plans, plans for year, month, week, day. To manage these plans and control carrying-out you should use time-management techniques (Life management (2010)).

Tucker, Armstrong, Massad, (2009) are investigated that a profile of a mind map user from the education sector is one that constructs hand-drawn maps, but a significant number employ mind mapping software (such as Inspiration). Users appreciate the ease in which a hand-drawn map may be created at any time or place, but they also see the drawback given today's technology of not having an electronic copy available. An advantage of mind mapping software is the ability to modify maps easily, but the cost is a deterring factor. Users in the education environment indicate that mind maps help them organize their ideas. They use mind maps for brainstorming, problem solving, preparing presentations and conducting research. Most mind map users from the business environment government environment are more like-minded than those from the education sector. They construct hand-drawn maps but a significant number of users employ software (such as MindManager). Business and government users share the same attitudes with users in education regarding the advantages and disadvantages of using hand-drawn maps. However, those in business and government differ in what they perceive as advantages and disadvantages of mind mapping software. Business users typically utilize mind maps for brainstorming and process improvement.

As concluded Santiago (2011) mind mapping is most useful during brainstorming, note-taking and developing clinical scenarios. Concept mapping's strength lies in forcing us to organize knowledge hierarchically. Thinking maps are powerful templates allowing the learner to develop metacognitive skills. Argument mapping is a critical thinking tool to formalize premises, counterarguments and conclusions.

2.7. Knowledge and visual information processing methods development necessity for Latvia

Although knowledge management methods are also used in Latvia, a lot of people, but their role we, unlike Western countries is too low. This applies especially to the education sector, as well as all the people the opportunity to improve the mainstreaming of 'human security issues. The reason for this is that at the national level has not yet assessed the methods of use and the possibilities to improve the citizens' welfare and public activities for targeted cooperation, which was not possible in the years of the occupation of Latvia. Therefore, there is a need for programmes to increase skills levels and reduce social exclusion of citizens.

As the critical sectors, where the use of the knowledge maps in my point of view are following:

- Development of new curriculum about knowledge maps and visual graphic techniques and personal organizers using in Latvian,
- The preparation of teaching staff for the implementation of the present and this object
- Internet resources preparation for sharing knowledges about knowledge maps and visual graphic techniques

- Development of new curriculum about human security for schools and citizens. On the basis of such a programme should be taken into account in the SWOT analysis and of the concept of mainstreaming of 'human security in the areas of the map.
- Implementation of the provisions of the strategic planning of government institutions and municipalities on the basis of systemic thinking
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2.7. Example of the mind map about the knowledge of the computer network concepts

The example of the mind map about the knowledge of the main computer network concepts for students is shown in the Figure 8 was made by author for Computer Networks curriculum. in this example, the mind map is intended for training students assessment in such a way that the student is in the specified time interval for each map end point extends the concept with its his own example, which learned the training process.

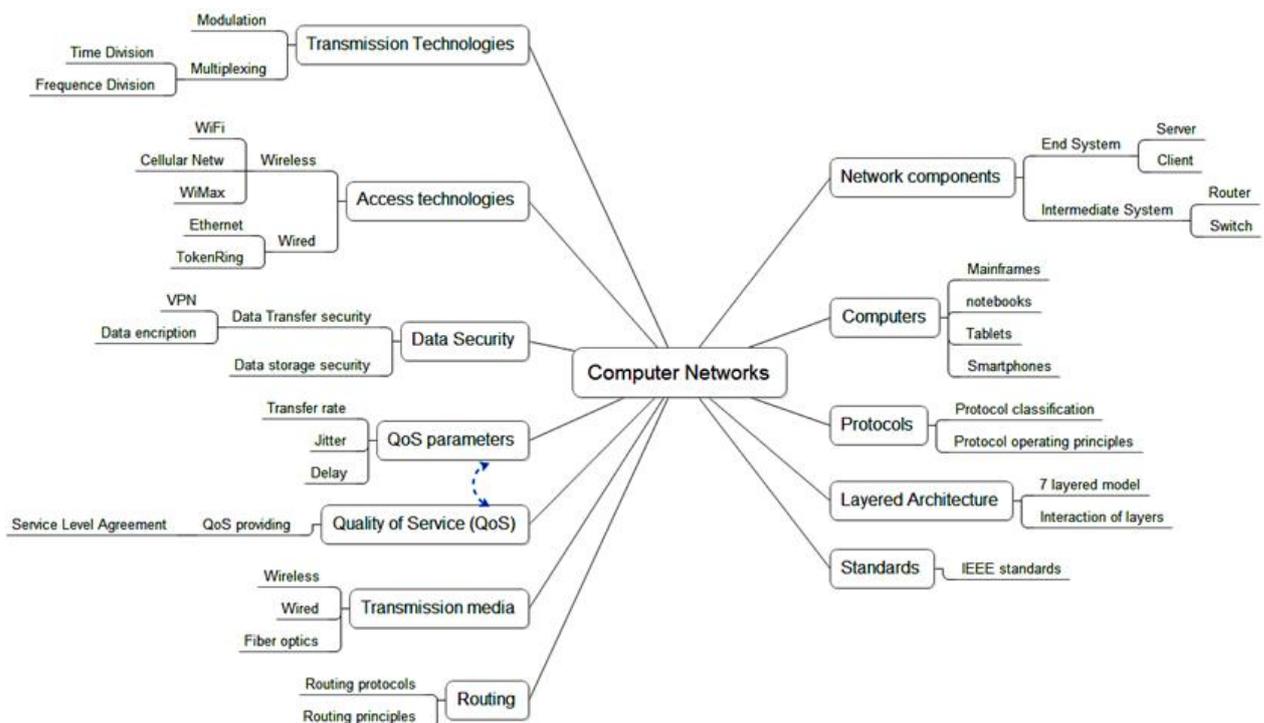


Figure 8. An example of Computer Networks curriculum mind map.

3. RESULTS AND DISCUSSION

This study was carried out in the course of a comprehensive knowledge maps and other graphical planning techniques and their opportunities analysis based mainly on the resources available on the Internet for their research and application in our country taking into account actual needs and putting forward some related proposals. In my view, actual proposals are:

- in education sector –
 - ✓ development of new curriculum about knowledge maps and visual graphic techniques using in Latvian

- ✓ preparation of teaching staff for the implementation of the present and this object
- ✓ Development of new curriculum about human security for schools and citizens on the basis of such a programme should be taken into account in the SWOT analysis
- ✓ preparation internet resources for sharing knowledges about knowledge maps and visual graphic techniques
- ✓ collaboration with western countries about knowledge maps and visual graphic techniques using
- In government and municipalities sector –
 - ✓ Implementation of the provisions of the strategic planning of government institutions and municipalities on the basis of systemic thinking
 - ✓ preparation internet resources for sharing knowledges about knowledge maps and visual graphic techniques life management
 - ✓ Stimulate between ethnical dialogues
 - ✓ Stimulate life-long education
- In business sector –
 - ✓ preparation internet resources for sharing knowledges about knowledge maps and visual graphic techniques for business and collaboration
 - ✓ usage knowledge maps and visual graphic techniques for strategic planning

CONCLUSION

I believe that the result of this work makes it possible to put forward concrete proposals for the development of knowledge, technology implementation plan at national level. I hope that this proposal will find support of the Government of Latvia

REFERENCES

- Aberbrese, A. (2013) Behind the Scenes: Conceptualizing the Mind-Map of the Entrepreneur when dealing with Strategic Problems Retrieved 21 Mai 2016
<http://chicago.ssrn.com/delivery.php?ID=322005083022084095001120112073112028039081023074004060009028106097017127005081068031027023115056106051041114066070099105010064123060059014080003122081001020097000100019041008098078116111023028089118122019089114116028020001123107072097076005003029092119&EXT=pdf>
- Biggerplate (2015) The Essential Guide to Getting Started with Mind Mapping Software. Retrieved 21 Mai 2016 http://mindmappingsoftwareblog.com/wp-content/9ms9/Essential_Guide_to_MMS.pdf
- Biggerplate (2016) Biggerplate annual report Retrieved 21 Mai 2016
<http://www.biggerplate.com/annual-report-2016>
- Buzan, T. Principles of mind mapping (1980) Retrieved Mai 2, 2016 from
<https://imindmap.com/how-to-mind-map/>

- Davies, M. (2010) Concept mapping, mind mapping and argument mapping: what are the differences and do they matter? Springer Science+Business Media B.V. 2010 Retrieved Mai 2, 2016 from https://www.academia.edu/448864/Mind_Mapping_Concept_Mapping_Argument_Mapping_What_are_the_differences_and_Do_they_Matter
- Davies, M. (2014) Computer-Aided ArgumentMapping as a Tool for Teaching Critical Thinking Retrieved Mai 2, 2015 from http://www.mitpressjournals.org/doi/pdf/10.1162/IJLM_a_00106
- Eppler, M. J. (2006). A comparison between concept maps, mind maps, conceptual diagrams, and visual metaphors as complementary tools for knowledge construction and sharing. *Information Visualization*, 5, 202–210. Retrieved Mai 2, 2015 from http://www.liquidbriefing.com/twiki/pub/Dev/RefEppler2006/comparison_between_concept_maps_and_other_visualizations.pdf
- Frey, C. (2010) Power tips & strategies for mind mapping software. Supercharge your visual mapping skills with these tips, tricks and best practice, 3-rd edition. Retrieved Mai 2, 2016 from <http://mindmappingsoftwareblog.com/wp-content/v3wmp/mind-mapping-ebook-v3.pdf>
- Ermuiza, A., Kalnina I., Kazaine I. (2014) Implementation options of additional professional study subjects in secondary schools curriculum. Retrieved Mai 2, 2016 from https://www.researchgate.net/profile/Andrejs_Ermuiza
- Goals C, 2003. Critical success factors for strategic thinking that works. Retrieved Mai 20, 2016 from http://media.wiley.com/product_data/excerpt/30/07879650/0787965030.pdf, accessed on 01/06/2010.
- isee systems (2006) Applying Systems Thinking and Common Archetypes to Organizational Issues. Retrieved Mai 28 2016 from http://www.iseesystems.com/Online_Training/course/overview/index.htm
- Life management (2010) Retrieved from <http://www.mind-pad.com/solutions/mind-mapping-for-life-management.htm>
- Novak, J., & Cañas A. (2008) The Theory Underlying Concept Maps and How to Construct and Use Them Institute for Human and Machine Cognition Pensacola Fl, 32502 www.ihmc.us Technical Report IHMC CmapTools 2006-01 Rev 2008-01 Retrieved 20 Mai 2016 <https://www.uibk.ac.at/tuxtrans/docs/TheoryUnderlyingConceptMaps-1.pdf>
- Riccentre (2010) SWOT analysis and PEST analysis (2010) Retrieved Mai 20, 2016 from <http://riccentre.ca/wp-content/uploads/2012/01/Session-1-Takeaways-Guidlines.pdf>
- Santiago, H. (2011) Visual Mapping to Enhance Learning and Critical Thinking Skills *Optometric Education* Volume 36, Number 3 / Summer 2011 http://journal.opted.org/articles/Volume_36_Number_3_VisualMapping.pdf
- SWOT blog (2012) How to conduct a personal SWOT analysis. Retrieved Mai 20, 2016 from http://mindmappingsoftwareblog.com/wp-content/p6mw3q/Personal_SWOT_Instructions.pdf
- The Ultimate Guide to Mind Mapping Software (2015). Retrieved Mai 20 2016 from <http://mindmapsunleashed.com/the-ultimate-guide-to-mind-mapping-software>
- Tucker, M., Armstrong,G., Massad , V. (2009) Profiling a mind map user: a descriptive appraisal *Journal of Instructional Pedagogies* Retrieved Mai 20 2016 from <http://www.aabri.com/manuscripts/09264.pdf>
- Twardy, C. R. (2013) Argument Maps Improve Critical Thinking Retrieved Mai 20, 2016 from <http://www.reasoninglab.com/wp-content/uploads/2013/10/Argument-Mapping-at-Work-2013.pdf>

Van Gelder, T. (2010). What is argument mapping? Retrieved Mai 2, 2016 from <http://timvangelder.com/2009/02/17/what-is-argument-mapping/>

Wenzhong, Z. (2009) Business Analysis Models. Retrieved Mai 20, 2016 from http://www.google.lv/url?url=http://www1.gdufs.edu.cn/jwc/bestcourse/kecheng/42/manage/edit/UploadFile/201091917261814.ppt&rct=j&frm=1&q=&esrc=s&sa=U&ved=0ahUKEwiYydaNy7HNAhWGKiwKHXnxBGMQFggTMAA&sig2=6HGXMwO5vO5i9ErIDzXfzg&usg=AFQjCNEvq1SZStQ6mxz1CUNFeN_xTVSdzw

Zeilik, M, Schau, C., Mattern, N., Hall, S., Teague, K. & Bisard, W. (1997). Conceptual astronomy: A novel model for teaching postsecondary science courses. American Journal of Physics, 65 (10): 987-996. Retrieved Mai 2, 2016 from <http://www.flaguide.org/cat/conmap/conmap2.php#fig1>